Trimet, Solar BEAM Top

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TOOLS:

- Dremel rotary tool (1)
- Hobby knife (1)
- Needlenose pliers (1)
  or longnose pliers
- Ruler (1)
- Safety glasses (1)
- Sandpaper (1)
  or metal file
- Soldering equipment (1)
- Third-hand tool (2)
  aka helping hand
- Wire cutters (1)

PARTS:

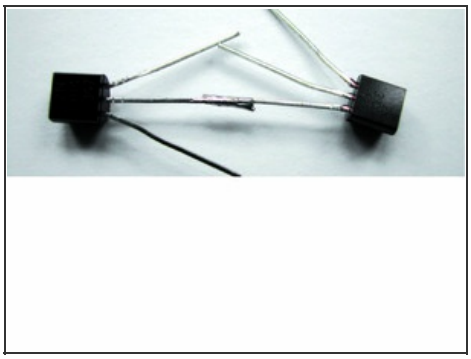
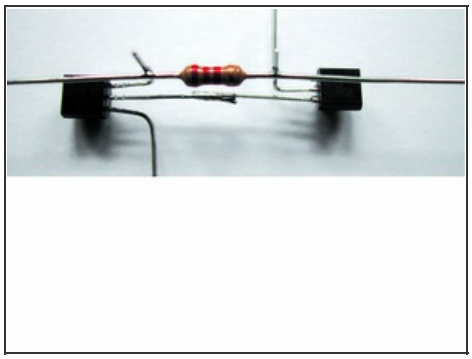
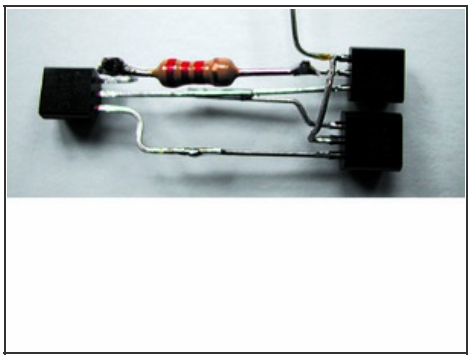
- Solar cell (1)
- Cassette motor (1)
  from an old Walkman or other player
- Voltage trigger IC (1)
- Transistor (1)
- Transistor (1)
- Poster putty (1)
  or tape
- Resistor (1)
- Capacitor (3)
- Hook-up wire (1)
- Paper clip (1)

SUMMARY

A Symet is a simple BEAM spinner that incorporates a common BEAM solar power management circuit called a voltage-tiggered (Type 1) Solar Engine. A "Trimet" is a Symet with three symmetrically-balanced components. A Trimet is basically comprised of the MSE, a DC motor scavenged from a cassette player, a solar cell, and three capacitors that store

the energy from the cell (and also act as the main structure of the "bot").

Step 1 — Building the voltage-triggered Solar Engine control circuit

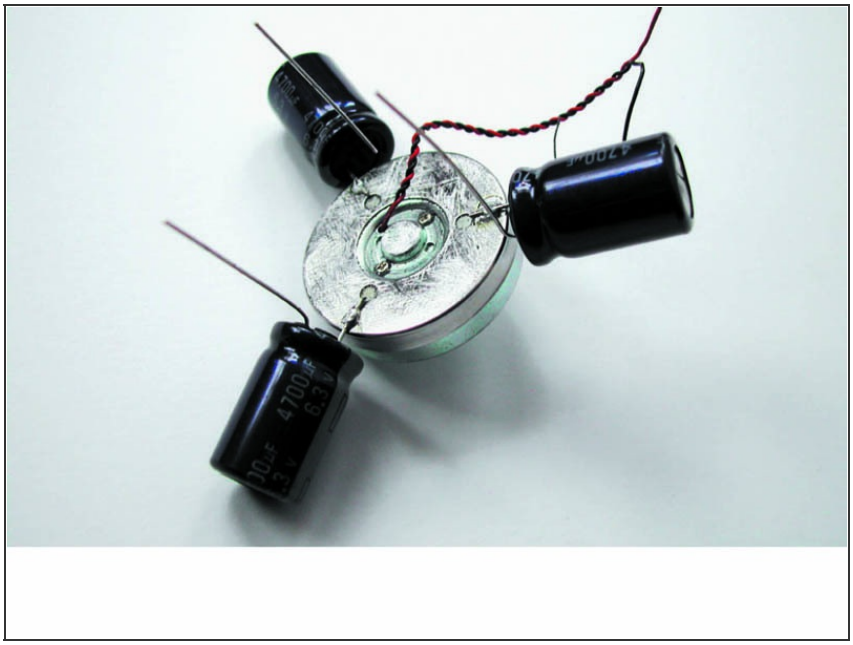




- We'll be freeforming this circuit, which means connecting components together directly, without a board. Normally I'd breadboard and test my circuits before soldering, but this one is so simple and has so few parts that we can live dangerously. Parts are easily desoldered and resoldered if there's a problem.
- Face the two transistors up with their pins toward each other. Solder the base pin (middle) of the 3904 transistor to the collector pin of the 3906 (the right pin, as you read the printing).
- Use needlenose pliers to gently bend the 3904 emitter pin (left) 90 degrees to the side and its collector (right) 90 degrees up. Bend the 3906 base pin (middle) 90 degrees up and its emitter (left) 90 degrees to the side. Solder the 2.2k resistor from the 3904 collector to the 3906 base.
- Trim excess lead length from previous step. Place the 1381 voltage trigger to the right of the 3906, facing the same way. Solder its Pin 3 (right) to the 3904 emitter and its Pin 1 (left) to the 3906 collector. Finally, arc its Pin 2 (middle) around and solder it to the 3906 emitter (left). There's your basic circuit, ready for motor and power!

Step 2 — Preparing the motor

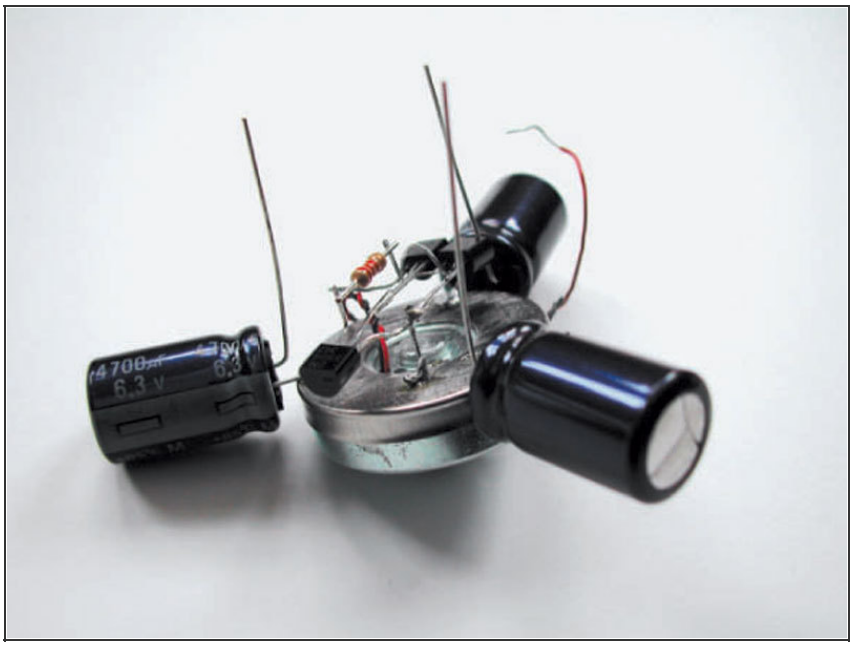
- Prepare the motor by removing any mounting tabs with a Dremel grinding wheel.
- Then use sandpaper or a metal file to scuff the drive-shaft side of the case until you're down to the shiny metal underneath. Really scuff it up good; you'll be soldering capacitors directly to the case, and they'll need to hold as the Trimet drags and bumps around.

Step 3 — Soldering on the capactors



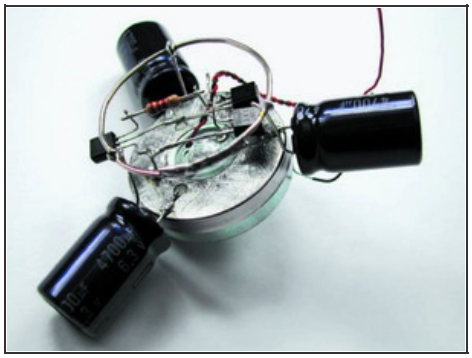
- Clip the negative/cathode leads on the three 4700µF capacitors so there's just enough wire to solder them to the motor casing.
- Bend the positive/anode leads up, making sure they comfortably clear the casing. Find 3 equidistant points at the perimeter of the motor, and solder the 3 cathodes to these points so that the capacitors form an equilateral triangle radiating out from the motor's center.
- Use generous gobs of solder, and use poster putty or tape to hold the caps in place while you solder.

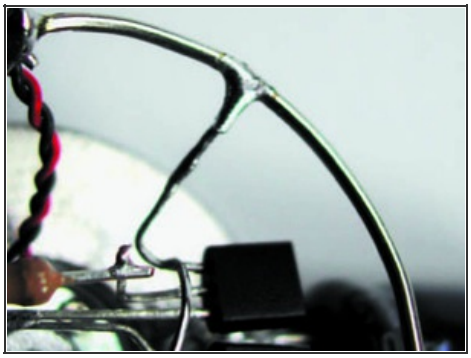
Step 4 — Attaching the solar engine circuit



- Center the circuit assembly over the motor, and solder a scrap lead from the 3904 emitter to the motor casing. This grounds the circuit, while also attaching it to the motor.
- For optimal balance, bend this connecting wire at 90 degrees, and try to position the circuit in the middle of the motor.

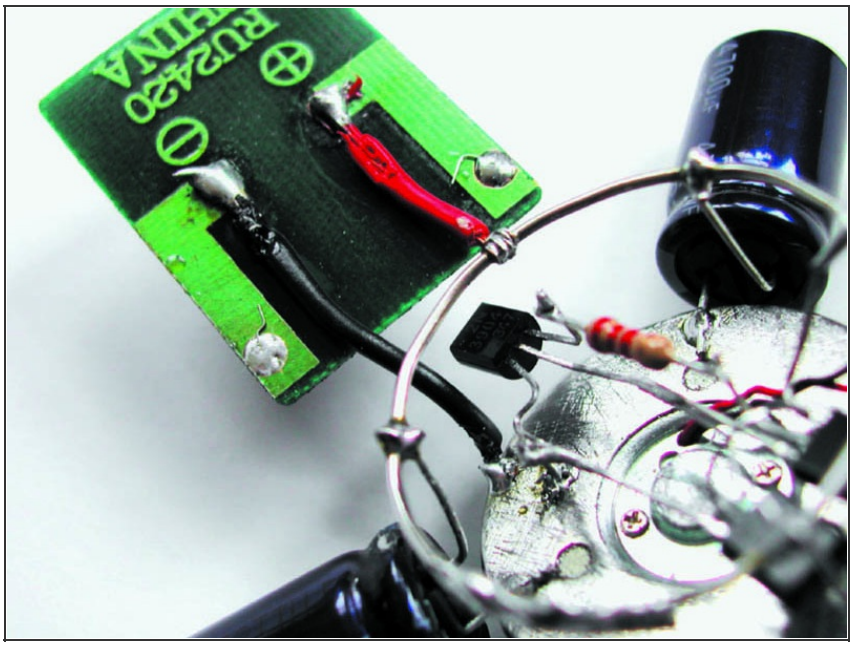
Step 5 — Creating and installing the "power ring"





- The motor case is our circuit's ground (-); now let's work on the power (+) side. Take a small paper clip and bend it into a ring with the same diameter as the motor.
- Conveniently, Walkman motors are the size of a quarter, so you can use one as a form to bend the clip around
- When you have a decent circle, solder it together
- Bend and trim the capacitor anode leads evenly, so that they extend just above the control circuit.
- Solder the "power ring" to the ends of the 3 leads, preserving the equilateral symmetry.
- If you can bend the 3906 emitter lead to reach the paper-clip ring, do so, and solder it on. Otherwise, connect it with a short piece of wire or scrap component lead.

Step 6 — Installing the solar cell



- If yours has pre-tinned pads but no wires (most small cells come this way), start by soldering the two wires onto it — but be careful, because solar cells are fragile.
- Then solder the positive/red wire to the ring and the negative/black wire to the motor casing.
- Make the wires long enough so you can still work on the circuit, but short enough so they'll stow neatly underneath when you finally glue the solar cell down onto the ring.
- Connect the motor. Solder the negative/black motor wire to the point where the 2.2k resistor meets the 3904 collector. Solder the positive/red motor wire to the paper-clip ring.

Step 7 — Attaching the solar cell and testing

- Place the solar cell on top of the Symet and shine a light on it, or put it in the sun. After 10 seconds or so, it should fire and scoot along, or spin around, if you're holding it by the driveshaft underneath.
- If so, congratulations — you're the proud parent of a baby BEAMbot! You can go ahead and glue the solar cell onto the paper-clip ring. Or, if the cell stays in place without glue, leave it that way so that people can peek under the hood.
- If your BEAMbot doesn't make you beam, carefully examine all connections, resolder anything that looks weak, and separate any components that might be touching (shorting). It's a simple circuit, so not much can go wrong besides incorrect connections or bad joins.

Step 8 — Resources

- There are many more hacks and variations on this project as well as other applications for the Solarengine. For more information, see “Getting Started in BEAM,” MAKE, Volume 06, page 57. Schematic for Miller variant of Solarengine circuit: http://makezine.com/06/beambots
- Try Andrew Miller’s more efficient variant of the basic Solarengine, which is almost as easy to build. You need a different resistor, an additional capacitor, and a diode, but you can lose the 3906 transistor. Varying the value of the small cap, between 0.47µF and 47µF, lets you “program” different discharge times. (See schematic at: http://makezine.com/06/beambots.)

Once you have the basic idea down, you can go crazy, improvising BEAMbots with greater storage capacity, better obstacle-avoidance strategies, or swankier, more attention-getting designs.

This project first appeared in MAKE Volume 06, page 76.

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